1430-489-50/2

*TB 9-1430-489-50

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR LANCE FORWARD MIRROR BRACKET ASSEMBLY-13048199, AZIMUTH CHECK TOOL-13047744, AND ELEVATION CHECK TOOL-13047743

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Headquarters, Department of The Army, Washington, D.C., *14 January 1985*

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this publication. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms) direct to: COMMANDER, U.S. ARMY MISSILE COMMAND, ATTN: AMSMI-SNPM, REDSTONE ARSENAL, AL 35898-5238. A reply will be furnished to you.

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SECTION I

IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of the Lance forward mirror bracket assembly 13048199, elevation check tool 13047743 and azimuth check tool 13047744. The equipment being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

a. Model Variations. There are no differences in models of the forward mirror bracket assembly 13048199, elevation check tool 13047743 and/or azimuth check tool 13047744.

b. Time and Technique. The time required for this calibration is approximately 1.0 hour each using the physical technique.

2. DA Form 2416 (Calibration Data Card)

a. Forms, records, and reports required for calibration personnel at all levels are prescribed by TB 750-25-1. DA Form 2416 must be annotated in accordance with TB 750-25-1 for each calibration performed.

b. Adjustments to be reported on DA Form 2416 are designated (R) at the end of the sentence in which they appear. When adjustments are in tables, the (R) follows the designated adjustment. Report only those adjustments made and designated with (R).

3. Calibration Description. TI parameters and performance specifications which pertain to this calibration are listed in table 1.

Table 1. Calibration Description

Test Instrument Parameters	Performance Specifications
Horizontal plane of machined surfaces	Within plane ±20 sec (0.10 mil)
Vertical plane of machined surfaces	Within plane ±20 sec (0.10 mil)

SECTION II

EQUIPMENT REQUIREMENTS

4. Equipment Required. Table 2 identifies the specific equipment to be used in this calibration procedure. This equipment is issued with Secondary Reference Calibration Standards Set, NSN 4931-00-621-7878. Alternate items may be used by the calibrating activity when the equipment listed in table 2 is not available. The items selected must be verified to perform satisfactorily prior to use and must bear evidence of current calibration. The equipment must meet or exceed the minimum use specifications listed in table 2. The accuracies listed in table 2 provide a four-to-one ratio between the standard and TI. Where the four-to-one ratio cannot be met, the actual accuracy of the equipment selected is shown in parenthesis.

5. Accessories Required. The accessories listed in table 3 are issued as indicated in paragraph 4 above and are used in this calibration procedure. When necessary, these items may be substituted by equivalent items, unless specifically prohibited.

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Table 2. Minimum Specifications of Equipment Required

Item	Common Name and/or Official Nomenclature	Minimum Use Specifications	Manufacturer, Model, and Part Number
A1	AUTOCOLLIMATOR	Micrometer range: ±5 min of arc Accuracy: ±1 sec of arc	Kollmorgan K221 7911743
A2	OPTICAL FLAT WITH MIRROR	Flatness accuracy: 1/4 wavelength of sodium light 8 in. long x 1-3/8 in. wide x 3 in. high mirror surface 2.5 in long	E&W Optical 7902794
A3	SURFACE PLATE	Flatness accuracy: level within ±0.0002 in. per foot.	Rahn Granite Surface Plate Co. GG-P-463, 36 x 48 in GR.A
A4	ELECTRONIC HEIGHT GAGE	Dual range: ±0.003 in. Accuracy: 2 percent 1 within 1/4 scale division	Federal Products Corp., Model 230P-121 7904823
A5	PRECISION GAGE BLOCKS	Range: 0.001 to 4.00 Accuracy: Class AA	Brown & Sharpe 7901267, Dearborn Gage Co., Type 81—SA 7900512
A6	SINE—CENTER	10 or 20 inch Accuracy: Class AA	Taft-Pierce Mfg. Co. (Part of 7916299)
A7	THEODOLITE 2 each	0.002 mil reading	Wild T2-76 or T2-68

Table 3. Accessories Required

Item	Common Name and/or Official Nomenclature	Description and Part Number
B1	ANGLE PLATE, 90°	6 in. long x 6 in. wide x 8 in. high external surface precision ground (MSS-5220-1) 7901623
B2	AUTOCOLLIMATOR MOUNT	Metal mount, married to autocollimator configuration with leveling jacks and traversing plate (Taylor-Hobson)
B3 [1]	C—CLAMP	Medium service, 6 inch; 2-1/2 in. deep throat 5120-00-203-6531
B4	OPTICAL FLAT ADAPTER	Internal front tapered 1-1/2 degrees tension adjustable; 1/2 in. long x 5-1/4 in. diameter x 7-1/2 in. high
B5	TABLE, SUPPORT	Use with surface plate 503-001711
B6	STRAIGHT EDGE	Parallelism accuracy: ±0.005 in. maximum 7903703
B7	DEBURRING KIT	Nicholson 7913158
B8	AUTOCOLLIMATOR ACCESSORY EQUIPMENT	Kollmorgan 7911242
B9	MANDREL, 5 IN.	2 in. dia (±0.001) x 5 in. lg w/ctr sunk ctr tap each end (±0.001 to ctr) — use with sine center (A6). 7916609 (Part of 7916299).
B10	BULKHEAD SIMULATOR	Mounts to rotary table (A7) to support azimuth check tool adapter P/N 11430213 or GSU (Part of 7916299).
B11	ROTARY TABLE	Two axes, 12 in. accuracy: 1 degree Pratt & Whitney or Leitz-Wetzler or Chicago Tool (Part of 7916299).
B12	INSTRUMENT STAND WITH THEODOLITE ADAPTER (2 EACH)	Brunson Model -231-1 (Part of 7916299)

[1] Additional equipment required.

SECTION III
PRELIMINARY OPERATIONS

6. Preliminary Instructions

a. The instructions outlined in this section are preparatory to the calibration process. Personnel should become familiar with the applicable sections before beginning the calibration.

b. Items of equipment used in this procedure are referenced within the text by common name and item identification number as listed in tables 2 and 3. For the identification of equipment referenced by item numbers prefixed with A, see table 2, and for prefix B, see table 3.

c. Before calibrating the forward mirror bracket, use the deburring stone (B7) and remove the nicks and gouges on the machined surfaces (figure 1).

d. Use the electronic height gage (A4) (see figure 8) and gage blocks (A5) to check the dimensions indicated in figure 1. Adjust the plungers as required. Seal the plunger screws with dimensional sealing wax No. 2.

NOTE

Unless otherwise specified, all controls and control settings refer to the TI.

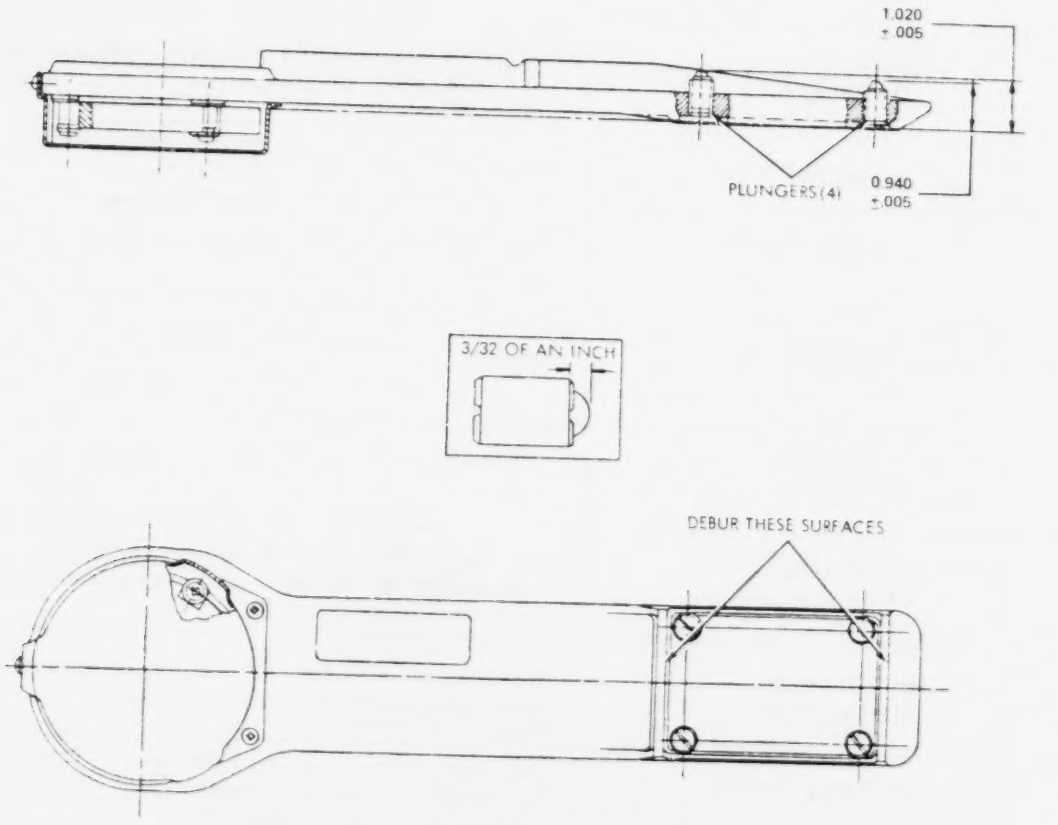

Figure 1. Forward Mirror Bracket Plunger Adjustment

7. Equipment Setup

NOTE

Before calibrating, allow a 2-hour minimum period for equipment to stabilize to environmental temperature.

a. Straight Edge Verification. Arrange straight edge equipment setup as shown in figure 2, following the steps listed below.

NOTE

The straight edge must remain in this clamped position throughout the calibration procedure.

(1) Clamp straight edge (B6) to surface plate (A3) as shown in figure 2.

(2) Attach steel mirror from autocollimator accessory equipment (B8) to stand and attach stand to 4-inch base.

(3) On straight edge, place two marks 18 inches apart. Identify the two positions as A and B as shown in figure 2.

(4) Install autocollimator (A1) into autocollimator mount (B2) and tighten trunnion bracket screws.

(5) With the mirror assembly base mirror at position A, place autocollimator in front of mirror assembly and level the autocollimator for horizontal measurement. To accomplish this, turn the autocollimator scale to zero and adjust the leveling jacks until the image is coincident with the autocollimator reticle. Record this reading which will be the reference indication.

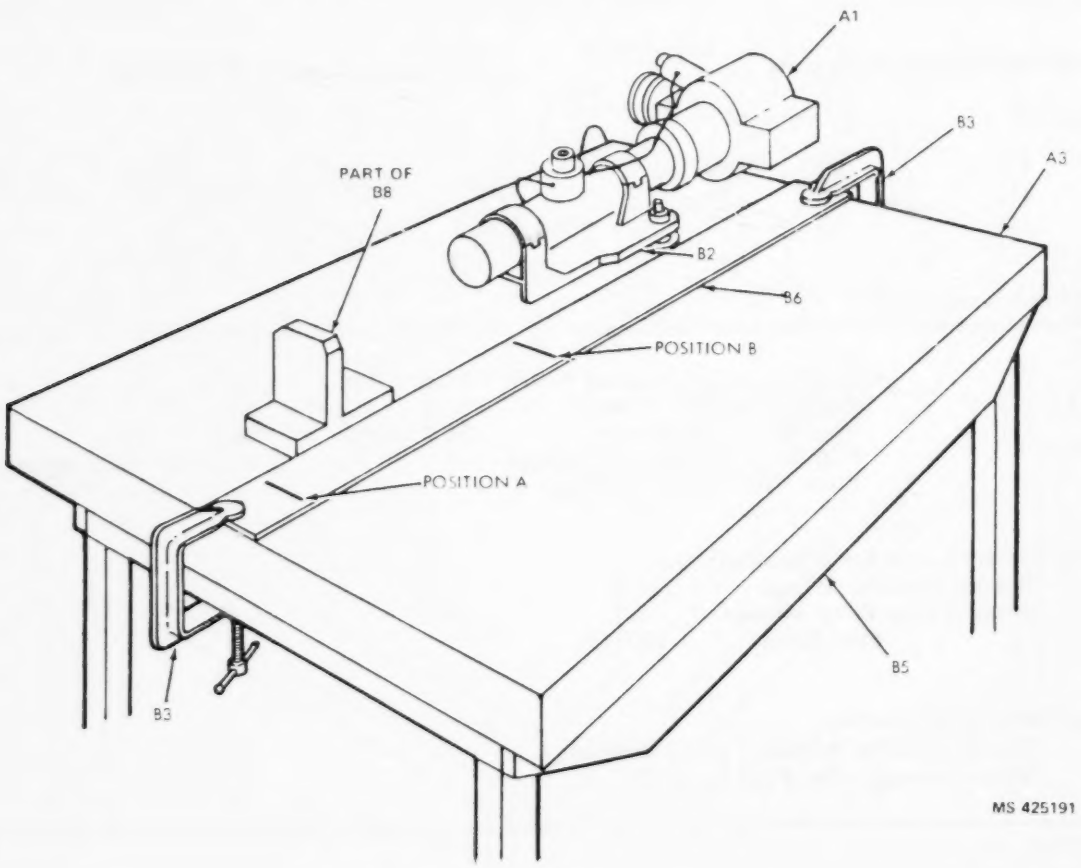

Figure 2. Straight Edge Verification Check

NOTE

A chart, similar to the one used in table 4, can be used to record and calculate the error.

(6) Inspect straight edge and mirror base surface plate for cleanliness. Remove foreign matter as required.

NOTE

If the straight edge is bumped or jarred at any time during performance of step 7 below, stop the operation and start over, using a new reference reading.

(7) Carefully slide the mirror base against straight edge to position B. Adjust autocollimator as required to aline the autocollimator with the mirror. Record this reading. This will be the test reading. Repeat procedure three times and record data as shown in example of table 4. Calculate the average straight edge error, identifying the error as either positive or negative. All three readings at each position must agree within 5 seconds.

Table 4. Example Chart and Recording

Straight Edge Reading in Seconds

A Position		B Position	
0	(1)	-3.7	(1)
0	(1)	-3.3	(1)
-0.4	(1)	-3.3	(1)

Difference/Error of Straightness

-3.7
-3.3
-2.9
-9.9 ÷ 3 = -3.3 Average

FWD Mirror Readings
Reference Mirror Readings at Point "B" in Seconds

5.2	(1)	Add Minus (-) Reference
3.8	(1)	Readings to FWD Mirror
7.9	(1)	Readings . . . Subtract
		Positive (+) Reference Readings
		From FWD Mirror Readings

FWD Mirror Readings at Point "A" in Seconds

27.4	(2)	22.2
21.9	(2)	18.1
34.7	(2)	26.8
		67.1 ÷ 3 = 22.3 Average (3)

Example for Horizontal Error Determination. . . .
Bracket Reading Average = 22.3
Straight Edge Error Average = - 3.3
Final Error 19.0 (3)

Vertical Error Determination. . . .
Bracket Reading Average + or - Reference Mirror Average is the Final Error (3)

[1] The difference between the largest and the smallest reference reading must not be greater than 5 seconds.
[2] The difference between the largest and the smallest reading must not be greater than 10 seconds.
[3] **The final error must not be greater than 20 seconds.**

b. Forward Mirror Bracket Setup. Arrange autocollimator test equipment setup as shown in figure 3, using the following instructions:

(1) Insert the end of the T1 into the optical flat adapter (B4) and insert the optical flat with mirror (A2) (aluminized surface toward autocollimator) between the adapter's tension adjusting screw and the mirror bracket's machined surface.

NOTE

The optical flat with mirror should be inserted into the adapter in sufficient depth to cover and rest firmly on the two parallel machined surfaces of the mirror bracket.

(2) Note the position of the spring-loaded plungers on the mirror bracket in their static position. Then tighten the optical flat adapter's tension adjusting screw until the spring-loaded plungers are depressed approximately 1/16 inch.

CAUTION

Do not bottom the spring-loaded plungers on the mirror bracket. Also, do not allow the collar of the plunger to contact the optical flat adapter. Any undue stress or strain imposed on the mirror bracket during calibration introduces error into the plane of the machined surfaces, possibly causing rejection of serviceable brackets.

(3) Attach the optical flat adapter (B4) to the flat side of the angle plate (B1), using C-clamps (B3).

(4) With the angle plate at position B, position the autocollimator in front of the optical flat so that the image of the autocollimator is reflected by the optical flat (A2) into the autocollimator reticle. Record the reading for the horizontal reference.

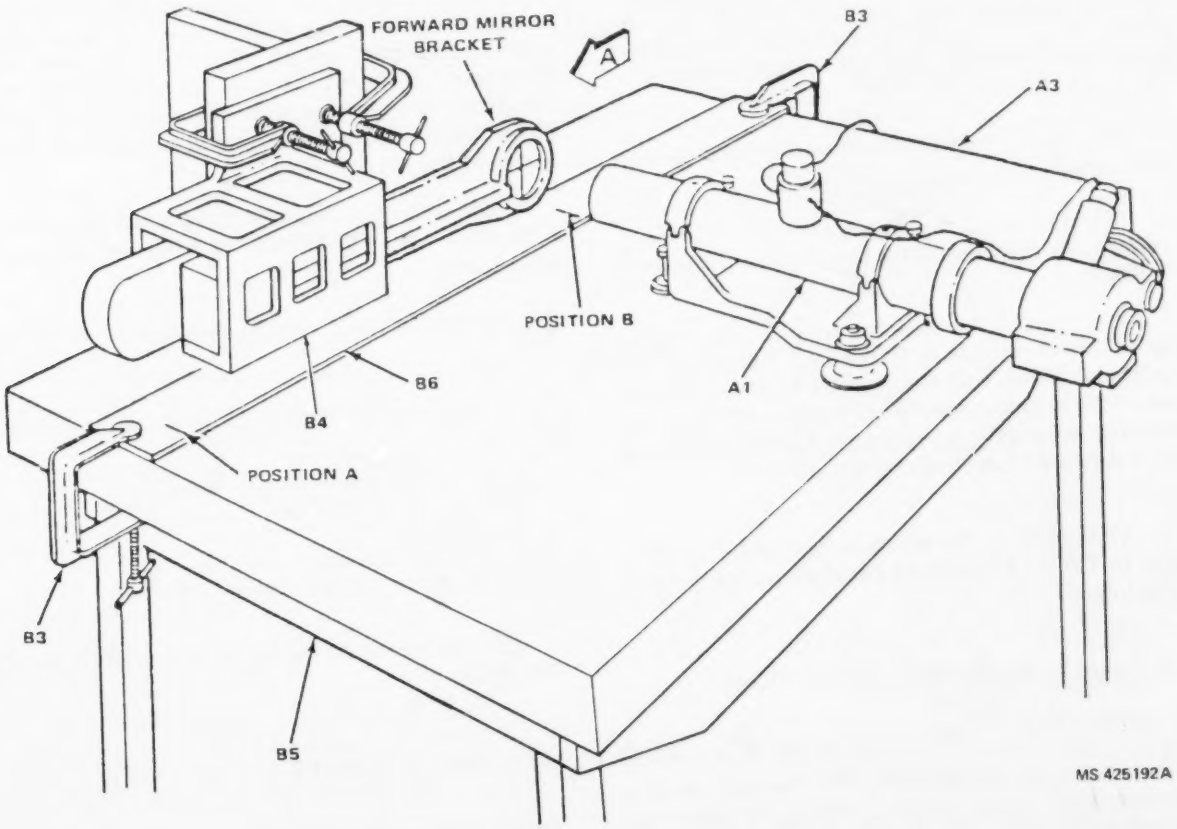

Figure 3. Forward Mirror Bracket Performance Check

SECTION IV
CALIBRATION PROCESS

NOTE

Straight edge verification must be performed prior to calibration and after calibration of each TI. If average error of straight edge has changed, repeat paragraph 7.*a*.

8. Forward Mirror Bracket (Horizontal Plane)

a. Performance Check

(1) Slide angle plate (B1) and optical flat adapter (B4) against straight edge (B6) to position A (figure 3) so the autocollimater (A1) reticle image is fully reflected by the TI mirror onto the autocollimator's reticle.

(2) The reflected image should be coincident with the autocollimator reticle. However, if the reflected image is not coincident, turn micrometer slowly until reflected image is brought into coincidence. Record reading.

(3) Take three readings and record data as shown in table 4.

(4) Compute the average of the difference between the reference settings (7.*b*.4) and the three readings.

(5) Add or subtract the error on the straight edge as shown in table 4. The average reading of the horizontal plane will not exceed 0 or the 0 reference) ±20 seconds, and the difference between the reference settings established for the three readings will not exceed 5 seconds of the arc.

b. Adjustments. No adjustments can be made. Refer to TM 9-1430-489-34 for FMB pad lapping procedures.

9. Forward Mirror Bracket (Vertical Plane)

a. Performance Check

(1) Loosen autocollimator clamps; rotate autocollimator (A1) approximately 90 degrees clockwise and tighten clamps.

(2) Level the autocollimator (A1) for vertical measurements.

(3) Slide the angle plate (B1) and optical flat adapter (B4) from position A against the straight edge to position B (figure 3), so that the autocollimator's image is fully reflected by the optical flat mirror (A2) onto the autocollimator.

(4) The reflected image should be coincident with the autocollimator reticle. However, if the reflected image is not coincident, turn micrometer slowly until reflected image is brought into coincidence. Record reading.

(5) Take three readings and record data as shown in table 4.

(6) Compute the average of the difference between the reference settings and the three readings. The average reading of the vertical plane will not exceed 0 (or the 0 reference) ±20 seconds, and the difference between the reference settings established for the three readings will not exceed 5 seconds of the arc.

b. Adjustments. No adjustments can be made. Refer to TM 9-1430-489-34 for FMB pad lapping procedures.

10. Azimuth Check Tool — Roofline Level Check

a. Performance Check

(1) Set up the equipment as shown in figure 4.

NOTE

Mounting surface of rotary table must be perpendicular to ground plane ±2 degrees.

(2) Mount bulkhead simulator (B10) to rotary table (B11).

NOTE

Rotary table support (B5) platform must be level prior to roofline check.

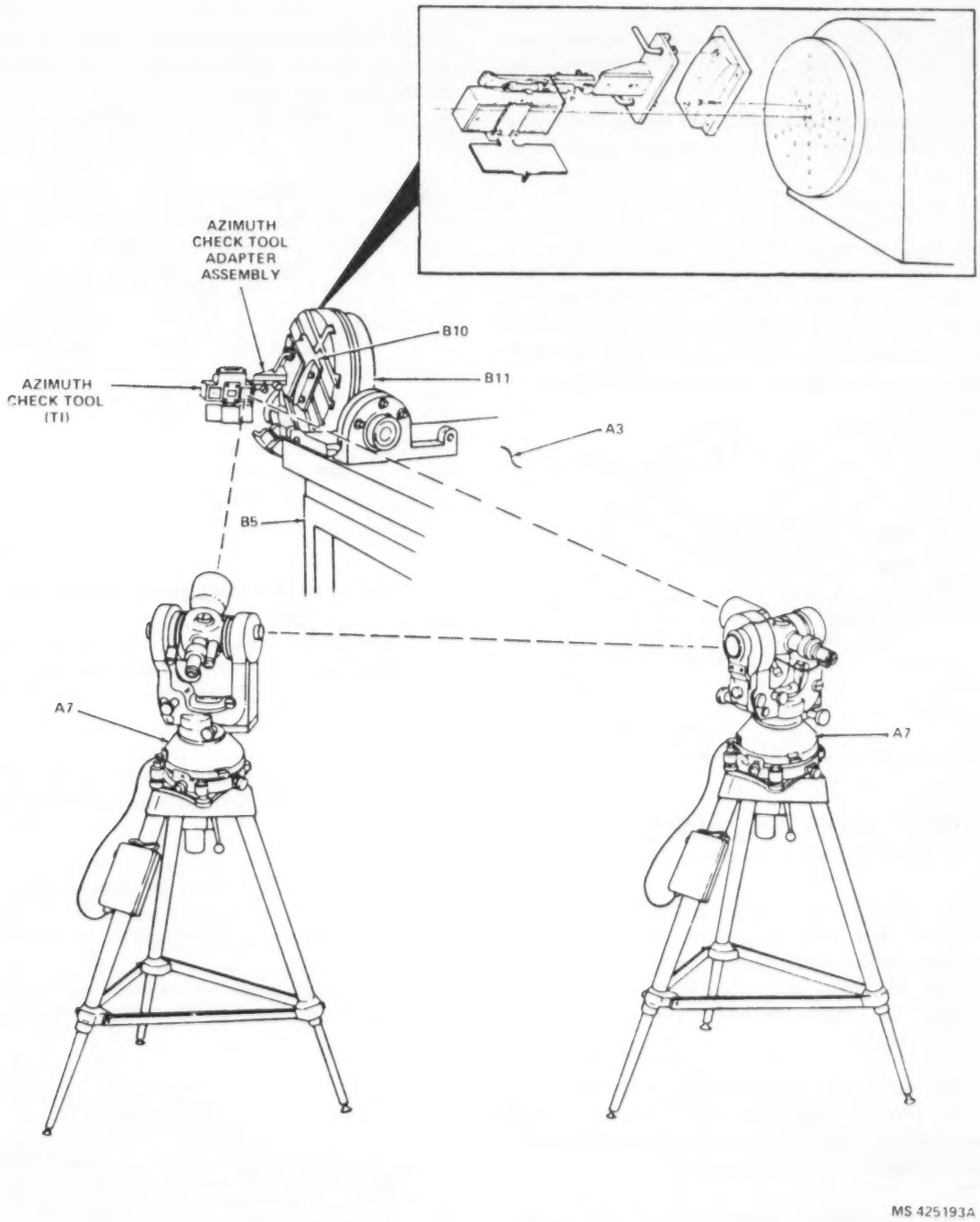

Figure 4. Azimuth Check Tool – Roofing Level Check

(3) Mount azimuth check tool adapter assembly (supplied with TI) to B10 and attach T1 to adapter.

(4) Insure that roofline of prism is directly in line with centerline of rotary table +1/4 in. as shown in figure 4.

(5) Position azimuth and cant adjusting screws on TI to center of travel.

(6) Use straight edge as shown in figure 5 and level check tool by rotating rotary table until straight edge is parallel to the ground plane.

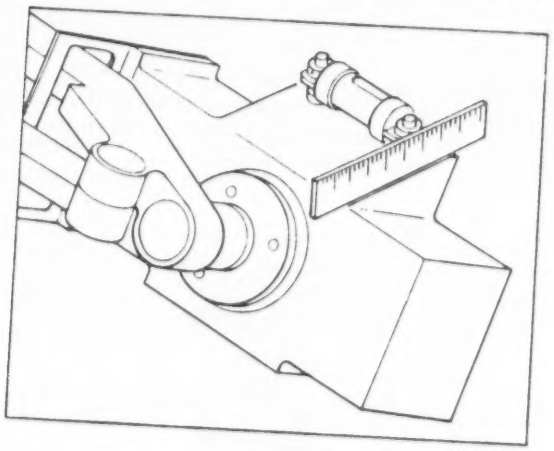

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Figure 5. Azimuth Check Tool Pre-Level Set Up.

(7) Position two theodolites (A7) (one base theodolite and one secondary theodolite) on adjustable instrument stands approximately 6 feet from the TI face, each on a line approximately (533 mils) 30 degrees on either side of the center line from the TI.

(8) Set both theodolites vertical circle readings to 1600.00 mils and adjust height of base theodolite and secondary theodolite to approximate height of TI (center of prism).

(9) Place plano mirror (part of B8) directly in front of illuminated theodolite lens (base and secondary) and by autocollimating the reticles adjust for infinity. Mark infinity setting on the focusing rings of each theodolite.

(10) Tape scale on right edge of aperture selected for test with significant number on scale adjacent to roofline of TI prism. Reference figure 6. Refocus each theodolite on the scale and roofline of prism.

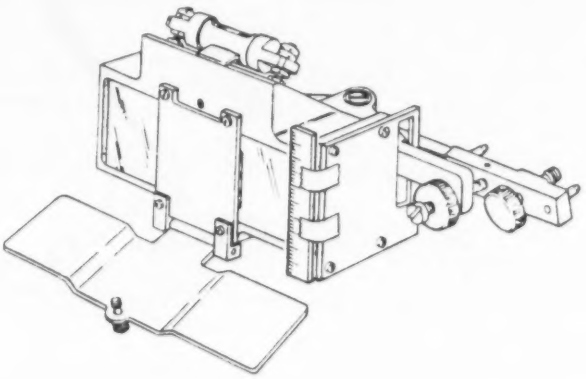

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Figure 6. Azimuth Check Tool – Roofline Set Up.

(11) Adjust height of base theodolite and secondary theodolite until horizontal line of theodolite reticle (both theodolites) is within 1/16 inch of TI prism roofline.

(12) Focuse base theodolite on TI and center on prism aperture then refocus base theodolite to infinity.

(13) Move secondary theodolite stand (sideways) until the theodolite reticle is centered on reticle of base theodolite (Reference Theodolite).

(14) Level base theodolite and secondary theodolite through 6400 mils (360 degrees).

NOTE

Left or right aperture may be used for roofline test as long as both theodolites are aligned to same aperture. It may be helpful to cover unused aperture to facilitate calibration of TI. the sum of direct and reverse (plunge) settings on a collimated target in elevation shall not differ from 6400 (±.015) mils (360 degrees).

(15) Verify the verticle circle settings (in elevation) of each theodolite by first alining the reticle of the base theodolite with the collimated reticle of the secondary theodolite. Set base theodolite vertical scale to 1600.00 mils (90 degrees).

(16) Reverse and plunge base theodolite and realine the reticle with the reticle of secondary theodolite. Vertical scale of base theodolite should read 4800 (±.015) mils (270 degrees ±3 seconds).

(17) Repeat procedure by alining the reticle of the secondary theodolite with the collimated reticle of the base theodolite. Set secondary theodolite vertical scale to 1600.00 mils (90 degrees).

(18) Reverse and plunge secondary theodolite and realine the reticle with the reticle of the base theodolite. Vertical scale of secondary theodolite should read 4800 (±.015) mils (270 degrees ±3 seconds).

(19) Point and focus base theodolite and secondary theodolites at TI aperture and adjust roofline of TI to obtain coincidence by using azimuth/cant adjusting screws (knobs) as shown in figure 7.

(20) Set focus ring of base theodolite and secondary theodolite to infinity setting determined in step (9) and set vertical circles to 1600.00 mils (90 degrees).

(21) Rotate rotary table 3 degrees forward.

NOTE

If vertical line of theodolite shifts greater than 1/3 off the field of view adjust azimuth adjusting knob of TI to obtain proper field of view.

(22) Adjust TI cant and azimuth adjusting knobs until horizontal reticle of secondary theodolite is coincidence with base theodolite.

(23) Record amount and direction of bubble level error.

(24) Rotate rotary table 6 degrees backward.

(25) Repeat step 22 and record amount and direction of bubble level error.

(26) Adjustments are required if the TI exceeds 1/2 increment when rotated through a 6 degree change in elevation (pitch plane).

b. Adjustments

NOTE

If error at both settings (step a. 20 and 22) are in the same direction, the error is primarily in pitch. If the error at both settings are in the opposite direction the error is primarily in yaw.

NOTE

If error is in yaw correct one half of the error by adjusting the eccentric nuts (both ends) until level is centered within 1/4 increment.

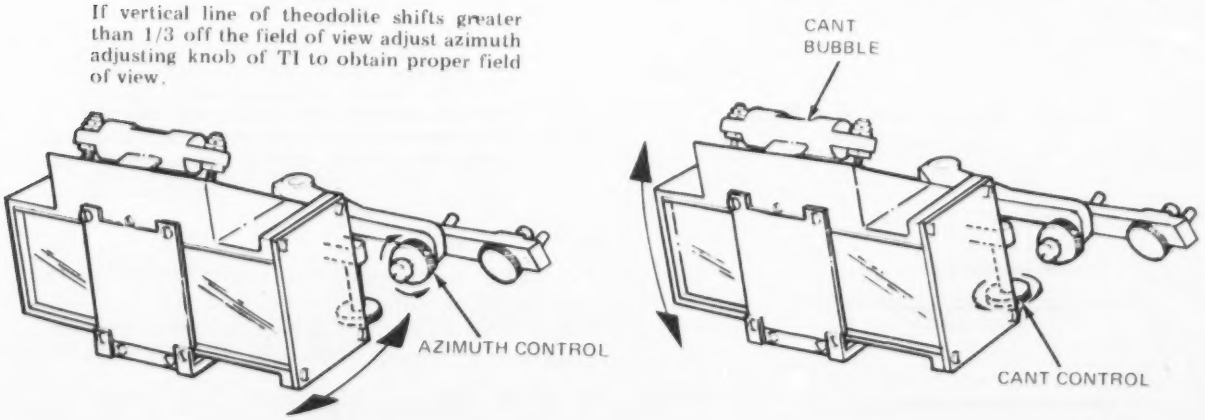

Figure 7. Azimuth Check Tool Cant/Azimuth Adjustment Controls.

NOTE

If error is in pitch adjust one end of level (capstan nuts), if error is less than one division. If greater than one division, adjust both ends of level.

(1) Rotate rotary table 3 degrees forward.

(2) Repeat step a. (19).

(3) Record amount and direction of bubble level error.

NOTE

To prevent possible bubble level drift caused by improper capstan nut orientation; ensure that the beveled (spherical face) surface of the capstan nuts rests on the level end tabs. For removal and replacement of capstan nuts and bubble levels (48/54 and cant levels) refer to chapter 3 of TM 9-1430-489-34.

(4) Adjust capstan and/or eccentric nuts until bubble level is centered within 1/4 increment as shown in figures 7, 8 and 9.

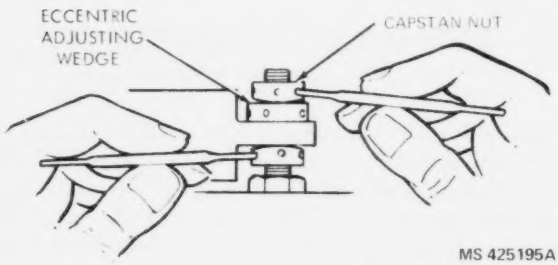

Figure 8. Azimuth Check Tool Bubble Level Adjustment

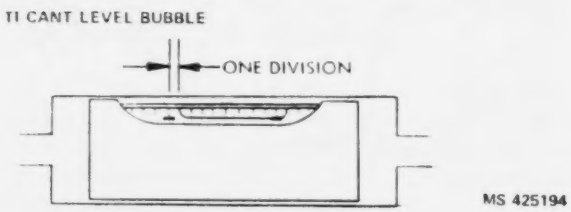

Figure 9. Azimuth Check Tool Bubble Level Tolerance

(5) Rotate rotary table 6 degrees backward.

(6) Repeat step a. (19).

(7) Record amount and direction of bubble level error.

(8) Repeat step b. (4).

(9) Repeat steps b. (1) through b. (8) until collimated lines remain in coincidence when the cant bubble level (within 1/2 increment) is rotated through a 6 degree change in elevation (pitch plane).

11. Elevation Check Tool — Bubble Set Check

a. Performance Check

(1) Arrange check setup as shown in figure 10, and verify that surface plate (A3) is level within 0.0002 in. per foot.

(2) Mount check tool (as shown on figure 10) on 2-inch bar stock (B9).

(3) Position (B9) in the sine-center tool (A6) on center between the two anvils.

(4) Prepare the appropriate stack of gage blocks (A5) for 48 degrees (7.4314 in.) and for 54 degrees (8.0902 in.) when using a 10-inch sine bar. (Double these figures for a 20-inch sine-bar.)

(5) Raise sine-bar to appropriate height (48 or 54 degrees) using proper stack of gage blocks (step (4) above).

NOTE

To prevent possible bubble level drift caused by improper capstan nut orientation; ensure that the beveled (spherical face) surface of the capstan nuts rests on the level end tabs. For removal and replacement of capstan nuts and bubble levels (48/54 and cant levels) refer to chapter 3 of TM 9-1430-489-34.

(6) Verify cross level (cant) bubble is leveled to mounting surface, using height gage (A4) on surface plate (A3). If bubble is not centered within one-half increment (0.05 mil), proceed to 11 *b.* (1).

(7) When check tool is cross leveled, verify appropriate elevation bubble level is centered within 1/2 increment (0.05 mil). If not, perform *b.*(2) below.

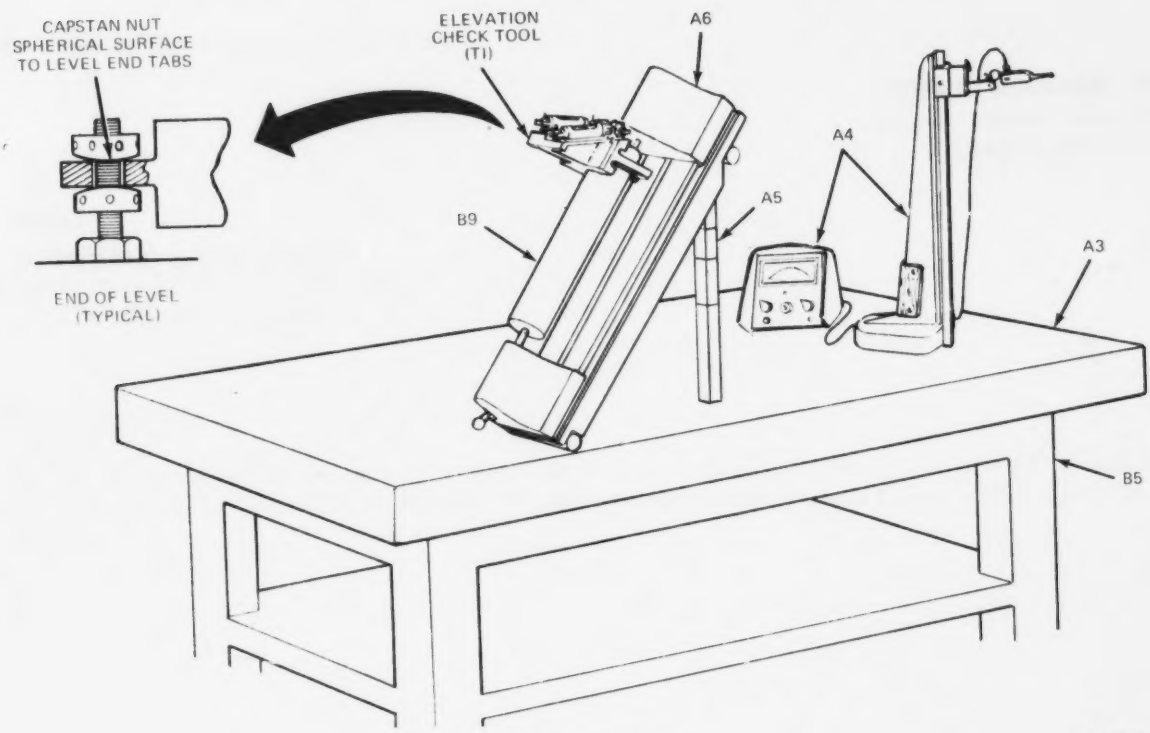

Figure 10. Bubble Set Check

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(8) Upon completion of one elevation setting, repeat procedure for other setting modifying height of stack blocks as appropriate. If not centered within 1/2 increment, perform *b.*(2) below.

(9) Apply torque paint to level adjustment nuts.

b. Adjustments

(1) Remove error in cross level (cant) bubble by adjusting capstan nuts to center the cross level (cant) bubble level.

(2) Assure that cross level (cant) bubble is centered. Remove error in appropriate elevation level by adjusting capstan nuts to center the elevation bubble level.

12. Final Procedure

a. Disconnect all equipment and replace TI's within their protective covers.

b. Verify that torque stripe is clearly visible on all bubble level capstan nuts.

c. When all parameters are within tolerance, annotate and affix DA Label 80 (US Army Calibrated Instrument). When the TI receives limited or special calibration, annotate and affix DA Label 163 (US Army Limited or Special Calibration). When the TI cannot be adjusted within tolerance, repair the TI in accordance with the maintenance manual. When repair is delayed for any reason or the TI cannot be repaired with local resources, annotate and affix DA Form 2417 (US Army Calibration System Rejected Instrument) and inform the owner/user accordingly in accordance with TB 750-25-1.

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